A Biomedical Engineering Graduate Industrial Internship Program: Structure, Implementation, and Evaluation

Khosrow Behbehani, Kevin D. Nelson, and Robert C. Eberhart

Joint Biomedical Engineering Program
The University of Texas at Arlington and
The University of Texas Southwestern Medical Center at Dallas

Abstract

A graduate industrial internship program is described that has been implemented in the joint graduate biomedical engineering program of the University of Texas at Arlington and the University of Texas Medical Center at Dallas for over a decade. Graduate students who complete 9 or more credit hours of graduate course work with a GPA ≥ 3.0 may elect to participate in the internship program. The interns work at industrial sites, either part- or full time. A faculty member serves as the advisor for the student and interfaces with the supervisor of the student at the firm. The advisor verifies that the assigned project provides the student with meaningful industrial experience and also monitors the student's progress. Participating students register for internship credit hours and receive a letter grade based on their performance. Participation in the internship program is optional and the accrued internship course credit hours are not applied toward the graduate degree course requirement. That is, they may not be substituted for required didactic or research credit hours. . However, the research findings associated with the industrial project may qualify as a non-thesis master's project, a master's thesis, or even a Ph.D. dissertation, depending on the scientific merit of the findings. Thus far, 25 students have successfully completed the internship program. All participants have successfully completed the internship program. Upon graduation, over 10% of the interns have been hired as full time employees by the company where they interned. The rest of the interns after graduation have become employed as engineers at other industrial firms or research laboratories.

Introduction

The majority of biomedical engineering (BME) graduates take employment in industry[1]. Presently, most of the students who choose biomedical engineering as a profession do so after completing a graduate degree in BME. However, most of the students entering the joint graduate BME program at the University of Texas at Arlington (UTA) and The University of Texas Southwestern Medical Center at Dallas (UTSW) do not have any industrial experience. In the past, most BME graduate studies have not provided a means for students to gain industrial experience. Over a decade ago, an internship program was established to provide industrial experience for the students. This program was initially started at UTSW on a relatively small

Proceedings of the 2003 ASEE Gulf-Southwest Annual Conference
The University of Texas at Arlington

scale, with only a few students from both UTA and UTSW participating. The program has always been open to the BME students from both campuses. Six years ago the internship program received funding from the Whitaker Foundation to enhance the program. This funding provided an impetus to restructure the program, formalize the internship process, and increase student participation. In this paper a description of the current structure of the internship program and the experience gained in running the program over the past six years is presented.

Internship Program

Structure

Student interns, faculty advisors, and industrial mentors form the backbone of the internship program. The students who are interested in gaining industrial experience are placed with one of the industrial partners, matching the student's capabilities with the needs of the partner. A mentor or supervisor from the firm is designated to guide the student through the assigned project(s). In addition to the industrial mentor, a faculty advisor from the BME program is assigned to monitor the student's activities at the industrial site, and to interface with the student's industrial mentor. The faculty advisor plays a dual role. First, he or she ensures that the project assigned to the intern will be beneficial to the student and contain scientific and engineering challenges that are relevant to the intern's interest. Second, the faculty advisor, in consultation with the industrial mentor, evaluates the student's performance on a periodic basis, at least once a semester. The student performance is evaluated by means of an oral or written progress report about the activities at the industry. The faculty advisor solicits input from the the industrial mentor about the quality of the student work and his/her productivity. The projects assigned to the interns are derived from the needs of the industrial partner to solve a design, manufacturing, or engineering enhancement problem. Some of the past projects included: sensor design using ball-shaped semiconductors, thermal control of devices used during coronary artery bypass graft (CABG) surgery, and deposit of micro-size peptide dots on biological substrates using jet ink technology. At the conclusion of the internship experience, the student prepares a report on the project and presents it to the faculty advisor and the industrial mentor.

The student and industrial partner mutually agree upon the level of student participation in the internship program. Specifically, the student may work part- or full-time. Three BME Industrial Internship Courses at 3, 6, and 9 credit hour levels have been established. Each semester, all interns, with the faculty advisor's approval, register for the internship course at the credit hour level that reflects the degree of their participation in the program. For instance, if during a semester a student is working only 10 hours per week as an intern, then the student may register for 3 credit hours during that semester. Alternatively, if during a semester a student spends 40 hours a week on his/her industrial internship project, the student may register for as many as 9 credit hours of industrial internship. In short, each semester the participating student must register for an internship course, commensurate with the level of student participation in the program during that semester. The number of semesters that a student participates in the internship program varies with the scope of the project that is assigned to the student. Most

students participate for two semesters. Often, these students work about 20 hours per week at the firm and at the same time take other courses toward their degree in BME. The internship courses are graded by the faculty advisor with input from the industrial mentor. The letter grade given to the intern becomes part of the on the student's academic record affecting the student's overall grade point average (GPA). It is noted that although the grades associated with the internship courses are used in computing the student's GPA, the internship courses are optional and not part of the degree requirements. However, since the internship course grades affect the GPA, it serves as a strong incentive for the interns to perform their internship duties at their best level.

The student internship project may be used as the research topic for the student's M.S. or Ph.D. thesis, if the scientific and engineering content of the project merit such an application, and if confidentiality issues can be resolved. The student must prepare a formal thesis on the topic and defend the thesis in front of an examining committee. If confidentiality is required by the industrial partner, the defense will be held in private and the thesis document will be placed in the library only after the intellectual property of the project has been protected through a patent application.

Implementation

Currently, the internship program is co-directed by the first two authors. In that capacity, the co-directors jointly conduct student recruitment, placement with industry, and advisement. From time to time, when one of the co-directors does not find himself qualified to serve as faculty advisor for an intern, he requests another colleague to serve in that capacity. Student recruitment is achieved by publicizing the internship program both internally within the BME program as well as externally through the use of brochures, posters and web pages. Students who are interested in the internship program must have completed 9 hours of graduate didactic course work in the program and earned a grade point average of 3.0 or higher. Through a competitive selection process, the students who are placed as an intern with industry may receive a $1000 scholarship, based on the availability of the funds for this purpose. In addition to recognizing the intern's success in entering the internship program and offsetting the cost of participation the internship program, the scholarship qualifies the intern for paying in-state tuition, a significant saving.

Most of the industrial partners are located in the greater Dallas-Fort Worth area. However, there have been several occasions when interns were place with firms as far away as Iowa and California. Representatives from the industrial partners periodically participate in an advisory meeting to critically review the internship program and to make suggestions for enhancements. Almost all interns receive remuneration for their services at the company. The level of financial compensation is negotiated by the intern with the industrial partner. Most interns work on a part-time basis and the average duration of an internship is about one year.

Evaluation

The main objective of the industrial internship program is to provide first-hand industrial experience to the BME students. The student evaluation of the internship program has been quite positive. One intern expressed his experience as: "*The internship program at UTSW/UTA gave me an inside look at the medical device industry. I was exposed to situations that are not easily simulated in a classroom environment. The experience and contacts made during the internship program help me to find a job at graduation.*" A majority of the students who took part in the program have stayed with the program for one year (i.e. two semesters). Approximately, 10% of the interns upon graduation were hired as full time employee by the firm in which they had worked as an intern. The rest of the 25 interns after graduation have taken engineering positions with other industry and research laboratories.

An added benefit of the internship program is that from time to time it may create an opportunity for a long-term collaboration between the industrial partner and the intern's faculty advisor. For instance, the project that an intern has worked on may generate new opportunities that can be pursued, after the intern has completed his/her internship with the firm. In such cases, the industry may sponsor the faculty advisor to continue the research on the project in his/her laboratory. As an example, a collaboration concerning further development of biocompatible material that an intern had worked on was established between one of the industrial partners and a faculty advisor. Another example of such sponsored research was the development of a control algorithm for temperature regulation of an organ bath used during cardiac surgery.

The distribution of the M.S. and Ph.D. students who participated in the internship program since its inception is approximately 10% Ph.D. and 90% M.S. students. This is expected, as most Ph.D. students aim to secure jobs in academia and research laboratories, instead of industry. The participation of female students in the internship program is significant and the ratio of the male to female students in the internship program (60% male and 40% female) approximates the current gender distribution in the BME student population (58% male and 42% female). The same ratio of male to female students has generally held true in the BME program over the years that the internship program has been available.

Summary and Conclusions

In summary, a graduate internship program in biomedical engineering has been described. The industrial internship program provides a valuable component to the engineering educational process by allowing students to put their newly learned tools to work. The industrial partners play a key role in shaping well-educated students through this program by providing hands-on experience in the industrial environment. The industrial partners have found the contribution of the interns valuable and have been eager to provide the experience for more students. When possible, the industrial partners have recruited the interns into permanent positions, The industrial internship program has been a very effective means of increasing collaboration

between the faculty and the industrial partners. Since the internship program requires participation of a faculty member as the academic supervisor, it creates regular interaction between the faculty member and the intern's supervisor at the industrial site. Such interactions may create opportunities for a long-term collaboration between the industrial partner and the faculty advisor on new projects brought about from the intern's work.

References

1. Occupational Outlook Handbook, 2002-03 Edition, U.S. Department of Labor, Bureau of Labor Statistics. The handbook is available at http://www.bls.gov/oco/pdf/ocos262.pdf.

KHOSROW BEHBEHANI
Dr. Behbehani serves as Professor and Director of the Biomedical Engineering Program at the University of Texas at Arlington. His area of interest is application of signal processing and control theory to biomedical engineering problems. He is a registered Professional Engineer in the State of Texas

KEVIN D. NELSON
Dr. Nelson is an Assistant Professor of Biomedical Engineering at The University of Texas at Arlington. His areas of interest are biomaterials and tissue engineering.

ROBERT C. EBERHART
Dr. Eberhart is Professor of Engineering in Surgery with the Department of Surgery at the University of Texas Southwestern Medical Center at Dallas. He served as the Director of the Joint Biomedical Engineering Program from 1984 to 2001. His areas of interest are biomaterials and tissue engineering.